Effects of Feeding Whole Cottonseed, Cotton Seed Cake and *Guizotia abyssinica* (Noug seed) cake on Blood Serum Parameters of Growing Arsi- Bale Male Goats

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Abstract— *The present study was designed to investigate the effect of feeding whole cotton seed, of Gossipium hirustum spp (WCS), cottonseed cake (CSC) and noug seed cake (NSC) on blood serum parameters of growing male goats. Twenty four Arsi-Bale growing male goats of 6-12 months of age were assigned at random to four dietary treatments in a randomized complete block design. The dietary treatments were; (T1) local grass hay only (control), (T2) control +20% WCS, (T3) control+30% CSC all amount on total daily DMI basis and (T4) control + recommended level noug seed cake(50% wheat bran (WB) and 49% NSC). Blood samples were collected in 10ml vactainer tube by jugular vein puncture every 30, 60 and 90 days of the experimental days and were allowed to clot at room temperature and centrifuged for 15minutesat 3000 rpm. The separated serum samples were stored in a deep freezer at -20^{o}C until they were analyzed. Te samples were analyzed for serum parameters: albumin, total protein, glucose, urea nitrogen, creatinine and alkaline phosphate Significant (P<0.05) difference between treatments was observed in the levels of creatinine, urea nitrogen, alkaline phosphate and albumin. Higher levels of creatinine and blood urea nitrogen were observed for T4 while higher alkaline phosphate was observed for T3 and higher albumin was observed for T2. However, no significant (P>0.05) difference between treatments were observed in the levels of total serum protein and glucose. Moreover, no visible clinical sign of gossypol toxicity was observed on the experimental goats fed WCS and CSC during the 90 days of the experimental period. Hence, it was concluded that supplementation of growing male goat diets with recommended levels of NSC,20 and 30% WCS and CSC respectively have no adverse effect on blood serum parameters of growing male goats.*

Keywords— blood serum parameters, cotton seed cake, goats, noug seed cake, whole cottonseed.

I. INTRODUCTION

Cottonseed cake and noug seed cake are both a by- products of oil producing plants obtained after the extraction of oil from cottonseed and noug seed respectively and they are produced in commercial quantity and used as main animal feed supplements in Ethiopia. The annual production of CSC and NSC is estimated at 7 million and 114,000 metric tons respectively (CSA, 2005). On the other hand, WCS is the main raw material produced mainly for its fiber to be used as a raw material in textile industries for garment production (ESTC, 2006). It is one of the most competitive feed supplements used in ruminant diets in developed countries like USA. Cotton seed contains high levels of both crude protein CP (20-40), energy (3.47 MCal ME) and it does not require further processing which makes it desirable by product feed (Poore and Rogers, 1995).

Naturally, both WCS and CSC are known for their gossypol content, a polyphenolic compound yellow pigment found in cotton plants mainly in the pigment glands of seed, roots, leaves and throughout the cotton plant though its level is relatively high in whole cottonseed (Smith, 1962; Berardi et al, 1980; Warren et al, 1988;Willard et al, 1995;). The toxic form of gossypol in WCS is considered to be as free gossypol (Berardi et al, 1980). However, ruminants can detoxify free gossypol by binding with soluble proteins in the rumen and making them physiologically inactive (Hawkins et al, 1985). Furthermore, Ward et al, (2008) reported that gossypol toxicity in functioning ruminants depend on several factors, which include the level of gossypol, the proportion of feeding form(ratio of free to bound gossypol), the relative proportion of the positive(+) and negative (-) isomers, the amount of WCS or cottonseed meal consumed and the efficiency of the detoxification action.In Ethiopia, cottonseed is grown in the lowland parts of the country that are free of frost and below an altitude of 1,400 meters above sea level .An estimated potential area of 2.6 million ha and a cultivated area of 1.7 million ha is used for cottonseed production, with annual production of cottonseed being about 84,000 tones -mainly under irrigation and some rain fed (Ethiopian Science and Technology Commission 2006). The same study also indicated that cottonseed is one of the industrial crops whose fiber and seed is supplied to textile factories and oil mills, respectively. However, this potential animal feed supplement is not used as animal feed in Ethiopia (Personal observation).

Contrasting to the above facts, shortage of animal feed supplement is one of the major constrains facing livestock production in general and small goat producers in particular (Tolera et al, 2000). Currently the problem of short supplies of animal feed supplements is more aggravated due to supply of the most commonly used animal feed supplement, NSC is in short as the consequence of growing demand of export market for oil crops and raw exportation of noug seed. Hence the price of protein feed supplements is becoming an affordable for smallholder farmers (Ethiopian Ministry of Industry and Trade, 2006).

In Ethiopia goat is an important component of livestock subsector and are source of cash income and play a vital role as source of meat, milk and wool for smallholder goat keepers in different farming system and agro-ecological zones of the country (EARO, 2000). Arsi Bale goats are small short legged; short ears and both short and long haired type with glossy, wavy and gray coat or dark in color and they are distributed in highlands of Bale, Arsi administrative zones and central rift valley of Ethiopia (Workneh, 2000). In traditional goat production system of Ethiopia goats though goats play a vital role in the livelihood of the smallholder goat producers they are left by their own for roaming and browsing on private/communal natural grazing lands, bushes and shrub land. Hence, due to large seasonal fluctuation in quantity and quality of feed supplies and critical shortage of feed goat lose weight they gain in rainy season of good feed suppliesindry season of critical feed shortage (Alemayehu, 2004). Thus, goat production in Ethiopia is characterized by low production and productivity (Tolera et al, 2000). Furthermore, the problem of feed shortage is more aggravated due to decline in size of grazing land from time to time due to expansion of cultivation, decrease in productivity of grazing lands as a result of poor management and frequent drought (Degefe and Nega, 2000). Consequently to increase goat production and productivity recent stress has been on utilization of crop residues which was categorized as waste in previous days and currently become major components of livestock feed (Bizuwerk et al, 2005). However, these feed sources are very low in their protein content which makes them less palatable and inefficiently utilized (Desalew, 2008). Thus, to overcome the critical feed shortage constraints and for efficient utilization of the fibrous feed the best option is strategic supplementation of these feed sources by locally available resource (Tolera et al, 2000).

Therefore, the current critical feed constraints demands to look for other option of feed supplements, and WCS could be one of the best options due to its multi- nutrient characteristic to minimize the feed constraint. However, information on how to utilize the cottonseed species available in Ethiopia as animal feed supplement is absent or very scares. Thus the objective of this study is to study the effect of supplementation of growing Arsi Bale male goat diets with WCS, CSC and NSC on blood serum parameters.

II. MATERIALS AND METHODS

2.1 Description of the area

The study was conducted at Adami Tulu Agricultural Research Center (ATARC) located in the Mid Rift Valley of Ethiopia at 167 km south of Addis Ababa, the capital city of Ethiopia. It lies at latitude of 7^{o} 9' N and 38^{o} 7' E longitude. The center is situated at an altitude of 1650 m above sea level. It has a relative humidity of 60% and receives average annual rain fall of 760.9mm with minimum and maximum average annual temperature of 12.7^{o}C and 27.2^{o}C respectively. The agro-ecological zone of the area is semi- arid and sub-humid covered with vegetation of acacia woodland type dominated by *Penisitum* and *Cenchirus* grass species. The pattern of annual rainfall distribution in the area is categorized as dry period December-February, short rain: March – May; main rain: June- August and early dry September- November (ATARC, 1998). The soil is fine sandy loam with sand, silt and clay in the proportion of 34:48:18, respectively.

2.2 Experimental animals and their management

A total of 24 growing young Arsi Bale male goats having 6 to 12 months of age were purchased from the local markets and they were quarantined for 15 days and vaccinated for goat pox, and injected Ivormeetin for internal parasite before the start of the experiment. Local grass hay was chopped approximately (5-7cm length particles) and fed adlib. Goats were housed in individual pen sheltered in wooden-floor open sided barn. They were blocked by body weight, with six goats per block and randomly assigned to four dietary treatments as follows; (1) local grass hay only (control) , (2) T1 +20% WCS, (3) T1 + 30% CSC all on DMI basis and (4) T1 + recommended level of NSC (49% NSC and 50% wheat bran (WB) supplemented diets. All four groups were fed control diet prior to 15 days of adaptation period and the actual data collection was started after 15 days of adaptation period when the experimental animals had been gradually acclimatized to their respective experimental feeds. A mineral mix was added to all diets and all goats had free access to fresh water. The amount of WCS, CSC and NSC added to each level was expressed as a percentage of daily totals DMI of goats (20 and 30% of total daily DMI WCS and CSC respectively) while NCS is added at recommended level. The local grass hay used was a mixture of *Chloris gayana*,

Andropogon abyssinicus, Pennisteum clandestinum, Trifolum spp and some legumes such as *Alysicarpus ruigosa* and it was traditionally produced.

The treatment diets were fed twice a day (8:00 and 17:00) and the refusal were collected every morning before 8:00AM. Individual intake were calculated using daily feed offered and refusal and animal body weight was determined every 15 days while their average daily gain was calculated as the difference between initial and final body weight over the interval of the experimental period (90days). Blood samples were collected in 10ml vacutainer tubes by jugular vein punctureat30, 60, and 90 of the experimental period. The blood samples were allowed to clot for two hours at room temperature and centrifuged for 15minutesat 3000 rpm and stored at -20^{o}C until they were analyzed.

2.3 Laboratory analysis

The stored serum samples were obtained and serum total protein, albumin, glucose, creatinine, urea nitrogen, alkaline phosphatase activities were analyzed using standard commercial kits.

2.4 Statistical analysis

Data generated were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) of SAS (2005) for randomized complete block design. When F-test was found significant (P<0.05) means were separated by Tukey's test.

III. RESULTS

The chemical composition of the experimental diets is indicated in Table 1. Comparing treatments by nutrient composition the DM content of all diets is very close to each other while crude protein content is much more varies and was the lowest for T1 (control) diet. This was due to lower CP content of poorly prepared local grass hay used as the basal diet which was very close to the minimum level of CP content required for maintenance of ruminant animal 7%. On the other-hand, NDF and ADF composition were decreasing with increasing levels of supplement diets which are indicative of high cell soluble matter.

TABLE 1
CHEMICAL COMPOSITION OF THE EXPERIMENTAL DIETS

Nutrient composition(%DM)	Inclusion levels of treatment diets (%DMI)			
	0	20%WCS	30%CSC	NSC
DM	93	94.9	93.37	92.49
CP	8.5	16.72	17.83	25.47
Ash	9.42	5.81	5.89	7.41
OM	90.5	94.19	94.11	92.59
NDF	87.8	46.8	50.38	38.93
ADF	47.9	15.6	22.65	21.82

3.1 Serum biochemistry indicators

Different studies (Wang et al., 1987; Deora et al., 1997; Nagalakshmi et al., 2000; Risco et al., 2002; Mena et al., 2004; Solaiman et al., 2009) have linked cottonseed ingestion and gossypol exposure to serum biochemistry disturbance and serum chemistry changes allow the recognition of an impending toxicological effect due to gossypol ingestion prior to the development of clinical sign. However, in the present study no visible clinical sign of gossypol toxicity was observed on the experimental goats fed WCS and CSC during the 90 days of the experimental period.

As shown in Table 3 significant (P<0.05) difference between treatments was observed in the levels of blood serum albumin and higher level (4.25 g/L) was observed for goats consumed 20% WCS followed by NSC and 30% CSC supplemented diets and lowest for the control group. On the other hand, no significant (P>0.05) difference between treatments was observed for the levels of blood serum total protein and glucose. The present study results also showed significant (P<0.05) difference between treatments in the level of blood urea N and higher level was observed for goats consumed noug seed cake supplemented diet followed by those goats fed on 30% CSC and 20%WCS supplemented diet and the lowest for control group.

Moreover, significant (P< 0.05) difference between treatments was observed in the levels of creatinine and alkaline phosphate and higher levels of creatinine was observed for goats consumed noug seed cake supplemented diets followed by

20% WCS and 30% CSC and the lowest for control group while higher levels of alkaline phosphate was observed for goats consumed 30% CSC followed by NSC and 20% WCS and the lowest for control group (Table 3).

TABLE 2
SERUM BIOCHEMISTRY OF GOATS SUPPLEMENTED WITH COMPARISON DIETS

Serum bio. Indicators	Levels of comparison diets				SL
	0	20%WCS	30%CSC	NSC	
Albumin (g/L)	3.39^{b}	4.25^{a}	3.85^{ab}	4.08^{a}	*
Total protein(g/L)	8.13	5.6	6.6	6.72	NS
UreaN(mmol/L)	15.50^{a}	26.25^{ab}	26.87^{ab}	30.58^{a}	*
Glucose (mmol/L)	35.36	31.59	39.13	37.1	NS
Creatinine(µmol/L)	1.06^{b}	1.35^{a}	1.35^{a}	1.98^{a}	*
Alkaline phosphate	150.81^{b}	280.88^{a}	423.88^{ab}	402.68^{ab}	*

means in the same row with different superscripts were significant at (P<0.05).

IV. DISCUSSION

This study presents the results of evaluation of the effects of supplementation of WCSCSC, and NSC on blood serum parameters of growing Arsi -Bale male goats. The absence of marked effect on majority of blood serum biochemical change indicators in the current study for goats fed on WCS and CSC might be due to low level of gossypol content of cottonseed used in this study or it might be due to tolerance capacity of goats fed the experimental diets. Pertaining to the levels of serum albumin the values observed in our study is much lower than the previous report by different studies (Kaneko ,1989; Benjamine, 1989; Coles 1986) for serum albumin levels for normal goats. This could be due to lower ages of goats used in the current study and the albumin level is low for lower age and male goats (Bennis et al., 1991). It could also possibly due to nutritional difference between goats(Kaneko et al.,1997).Furthermore, the significant difference observed in levels of blood urea nitrogen between treatments and higher values 15.5 – 30.58mmol/L observed in the present study for NSC with high protein content could be attributed due to blood urea nitrogen concentration in ruminants is closely related to the rate of protein breakdown and ammonia utilization for bacterial protein synthesis in the rumen (Pattanaik et al., 2003) and an increase in blood urea nitrogen concentration may be reflected an accelerated rate of protein catabolism. Likewise Butler, (1998) reported that higher blood urea nitrogen in lambs fed concentrate diet and suggested that this might be the result of incapacity of ruminal micro flora to detain maximum ammonia. However, the values of blood urea nitrogen observed in our findings was lower than (Benjamine, 1989)who reported a value of blood urea nitrogen concentration of 7.64 - 22.92 mmol/L but, the values of the present findings was within the range of Castro et al, (1977) who reported the value of 17.80±3.13 mmol/L and Shaikat et al. (2013) who reported a value of 19.6±4.01mmol/L for goats less than 24 months of age and indicated that levels of blood urea nitrogen varies with the age of animals. However, the result of our findings is in contrast to Kaneko, (1989) who reported the value of 3.57 ±7.14 mM/L blood urea nitrogen concentration for normal goats and Gray et al,(1988) who reported the mean value of 5.34±2.29 mmol/L and 7.40mM/L for Landrace Danish goats and cross-bred goats respectively. The other factors attributed for the variation of the level of blood urea nitrogen observed in our study from other studies could be the difference in the housing, feeding and management of the animals (Carlson,1996; Johnston and Morris,1996).This variation in blood urea nitrogen concentration between different studies result and our findings might also be possible due to renal failure that might be due to gossypol negative effect of WCS and CSC that induces increase in blood serum urea nitrogen production or it could be due to difference in their breed, sex or age. Hence serum biochemical parameters varied with breed, age, sex and different environment (Sakha et al, 2009)

On the other hand, the insignificant difference between treatments in the level of total serum protein and low concentration value of 5.6 - 8.13g/L blood total serum protein observed in the present study could be attributed due to lower age of goats used in our study (Deangelino et al,1990).However, the current findings is in contrast to previous studies by Kaneko,(1989) who reported the value of 64 – 70g/L, 60 - 75g/L and 64-79g/L in normal goats. This could be possibly due to nutritional difference between goats (Kaneko et al. 1997). But, Mena et al.(2004) reported serum total protein was not influenced by diet. Moreover, blood glucose concentration levels value31.59 – 39.13 mmol/L observed in the present study is in consistence with Bennis et al. (1991) and Castro et al. (1977) who reported glucose concentration of 38.1±mmol/L for Morocoean Sahara goats and suggested that male goats have more glucose level than females and as age goes, the

concentration will be increased. Moreover, Sano et al, (2007)who reported that increase in glucose concentration may be due to more by pass protein and increased availability of glucogenic amino acids for glucose synthesis. However, the current result is lower than the previous report by Mbassa et al. (1993) who reported the value of 71.38±0.65 mmol/L for Landrace Danish goats and suggested that young goats have higher level of blood serum glucose concentration than adults and there is no significant difference for different sex. However, the result of our findings was in contrast to previous studies (Benjamine, 1989; Cole, 1986) who reported a glucose concentration range of 2.78 - 3.89mmol/L for normal goats.

Furthermore, the significant difference observed in the current study between treatments in the level of creatinine and alkaline phosphate for goats consumed supplemented diets could be possibly due to high protein content of NSC and WCS and in the process of rumen fermentation this might induce high production of urea and lack of efficient utilization of produced urea might have a negative effect on liver and kidney function followed by infection which might attributes for higher levels of creatinine and alkaline phosphate. This findings is in consistent with different previous studies (Kaneko, 1989; Benjamine, 1989) reported a value of 88.4- µM/L159 for creatinine in normal goats. Lower value of creatinine observed in the present study could be possibly due to lower age of goats used in the current study and it increases with age which could be attributed to the growth and gaining of muscle mass (Kubkomawa et al, 2015) or it could also be due to absence of the negative effect of composition of diets used in this study on the creatinine levels which might lead to creatiniemia and increased creatinine levels as reported by Morgan et al.(1988) who reported that serum creatinine kinase is usually high in diseases of heart, skeletal muscle and brain because there are large quantities of enzyme in these organs and even a mild injury can release it into the circulation system.

Moreover, a significant difference between treatments in the levels of alkaline phosphate of goats consumed supplemented diets observed in this study could be due hepatic dis-function attributes to toxic effect of gossypol in WCS and CSC. Likewise, Solaiman et al, (2009) reported that alkaline phosphate was higher in goats fed on diet containing 15.7% ECS for 140 days and they also indicated that alkaline phosphate is of interest because of its location in the plasma membrane. Moreover, the high level of alkaline phosphate observed in the present study could be attributed due to lower age of goats used for our experiment and alkaline phosphate level is higher for younger animals than adults and it decreases with age (Kubkomaw et al, 2015). Furthermore, Murray et al, (1993) indicated that a high alkaline phosphate concentration might be a direct response to liver and bone injury as a result of gossypol toxicity. In contrast, to the present study Colin-Negrete et al. (1996) reported that there was no change in the alkaline phosphate concentration in growing Holstein cows that had consumed 30% WCS for 144 days but observed a linear decrease in the alkaline phosphate levels after 430 days.

V. CONCLUSION

The present study indicated that supplementation of 20 and 30%WCS and CSC respectively of total daily DMI of goat diets could be a better alternative feed supplement that could support good performance and replace the commonly used feed supplement noug seed cake to minimize the critical shortage of feed supplement facing smallholder goat producers in Ethiopia. Moreover, easy access to WCS in the country and its characteristic of not need further processing make WCS a valuable feed supplement. However, for wide implementation of the results of the present work and extension of its use as alternative option further research work using female goats and large animal like dairy and beef is paramount.

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